



# **MARKSCHEME**

**November 2012**

**MATHEMATICAL STUDIES**

**Standard Level**

**Paper 2**

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Assessment Centre.*

**Paper 2 Markscheme  
Instructions to Examiners**

**Notes:** If in doubt about these instructions or any other marking issues, contact your team leader for clarification.

**1 Abbreviations**

**M** Marks awarded for **Method**

**A** Marks awarded for an **Answer** or for **Accuracy**

**R** Marks awarded for clear **Reasoning**

**G** Marks awarded for correct solutions obtained from a **Graphic Display Calculator**, when no working shown.

**AG** **Answer Given** in the question and consequently, marks not awarded.

**ft** Marks that can be awarded as **follow through** from previous results in the question.

**2 Method of Marking**

- (a) All marking must be done in scoris using the mathematical studies annotations and in accordance with the current document for guidance in e-marking Mathematical Studies SL. It is essential that you read this document before you start marking.
- (b) If a question part is completely correct use the number tick annotations to award full marks. If a part is completely wrong use the **A0** annotation, otherwise full annotations must be shown.
- (c) Working crossed out by the candidate should not be awarded any marks.
- (d) Where candidates have written two solutions to a question, only the first solution should be marked.
- (e) If correct working results in a correct answer but then further working is developed, full marks may **not** always be awarded. Full marks **will** be awarded if the candidate shows correct working leading to the correct answer. See also section 4(c).

**Example:** Calculate the gradient of the line passing through the points (5, 3) and (0, 9).

Markscheme	Candidates' Scripts	Marking
$\frac{9-3}{0-5} \quad (M1)$ <p><i>Award (M1) for correct substitution in gradient formula</i></p> $= -\frac{6}{5} \quad (A1)$	<p>(i) <math>\frac{9-3}{0-5} = -\frac{6}{5}</math></p> <p>Gradient is <math>= -\frac{6}{5}</math></p> <p style="text-align: right;"><i>(There is clear understanding of the gradient.)</i></p> $y = -\frac{6}{5}x + 9$	<p style="text-align: right;"><b>(M1)</b></p> <p style="text-align: right;"><b>(A1)</b></p>
	<p>(ii) <math>\frac{9-3}{0-5} = -\frac{6}{5}</math></p> $y = -\frac{6}{5}x + 9$ <p style="text-align: right;"><i>(There is confusion about what is required.)</i></p>	<p style="text-align: right;"><b>(M1)</b></p> <p style="text-align: right;"><b>(A0)</b></p>

### 3 Follow-through (ft) Marks

Errors made at any step of a solution affect all working that follows. To limit the severity of the penalty, **follow through (ft)** marks can be awarded. Mark schemes will indicate where it is appropriate to apply follow through in a question with **‘(ft)’**.

- (a) Follow through applies only from one part of a question to a subsequent part of the question. Follow through does not apply within the same part.
- (b) If an answer resulting from follow through is extremely unrealistic (for example, negative distances or incorrect by large order of magnitude) then the final **A** mark should not be awarded.
- (c) If a question is transformed by an error into a **different, much simpler question** then follow through may not apply.
- (d) To award follow through marks for a question part, **there must be working present for that part**. An isolated follow through answer, without working is regarded as incorrect and receives no marks **even if it is approximately correct**.
- (e) The exception to the above would be in a question which is testing the candidate’s use of the GDC, where working will not be expected. **The markscheme will clearly indicate where this applies**.
- (f) Inadvertent use of radians will be penalized the first time it occurs. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for the use of radians.

**Example:** Finding angles and lengths using trigonometry

Markscheme	Candidates’ Scripts	Marking
<p>(a) <math>\frac{\sin A}{3} = \frac{\sin 30}{4}</math> (MI)(AI)</p> <p>Award (MI) for substitution in sine rule formula, (AI) for correct substitutions.</p> <p><math>A = 22.0^\circ</math> (22.0243...) (AI)(G2)</p>	<p>(a) <math>\frac{\sin A}{4} = \frac{\sin 30}{3}</math></p> <p><math>A = 41.8^\circ</math></p> <p>(Note: the 2<sup>nd</sup> (AI) here was not marked (ft) and cannot be awarded because there was an earlier error in the same question part.)</p>	<p>(MI)(A0)</p> <p>(use of sine rule but with wrong values)</p> <p>(A0)</p>
<p>(b) <math>x = 7 \tan (22.0243\dots^\circ)</math> (MI)</p> <p><math>= 2.83</math> (2.83163...) (AI)(ft)</p>	<p>(b) case (i) <math>x = 7 \tan 41.8^\circ</math></p> <p><math>= 6.26</math></p> <p>but case (ii) <math>6.26</math></p>	<p>(MI)</p> <p>(AI)(ft)</p> <p>(G0)</p> <p>since no working shown</p>

**4 Using the Markscheme**

- (a) **A** marks are **dependent** on the preceding **M** mark being awarded, it is **not** possible to award **(M0)(A1)**. Once an **(M0)** has been awarded, all subsequent **A** marks are lost in that part of the question, even if calculations are performed correctly, until the next **M** mark.  
The only exception to this will be for an answer where the accuracy is specified in the question – see section 5.
- (b) **A** marks are **dependent** on the **R** mark being awarded, it is **not** possible to award **(A1)(R0)**. Hence the **(A1)** cannot be awarded for an answer which is correct when no reason or the wrong reason is given.
- (c) In paper 2 candidates are expected to demonstrate their ability to communicate mathematics using appropriate working. Answers which are correct but not supported by adequate working will **not always receive full marks**, these unsupported answers are designated **G** in the mark scheme as an alternative to the full marks. Example **(M1)(A1)(A1)(G2)**.

**Example:** Using trigonometry to calculate an angle in a triangle.

Markscheme	Candidates' Scripts	Marking
(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ <b>(M1)(A1)</b> Award <b>(M1)</b> for substitution in sine rule formula, <b>(A1)</b> for correct substitutions.  $A = 22.0^\circ$ (22.0243...) <b>(A1)(G2)</b>	(i) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ $A = 22.0^\circ$  (ii) $A = 22.0^\circ$ <i>Note: G marks are used only if no working has been shown and the answer is correct.</i>	<b>(M1)(A1)</b>  <b>(A1)</b>  <b>(G2)</b>

- (d) **Alternative methods** may not always be included. Thus, if an answer is wrong then the working must be carefully analysed in order that marks are awarded for a different method consistent with the markscheme.  
Where alternative methods for complete questions are included in the markscheme, they are indicated by '**OR**' etc.
- (e) Unless the question specifies otherwise, accept **equivalent forms**. For example:  $\frac{\sin \theta}{\cos \theta}$  for  $\tan \theta$ .  
On the markscheme, these equivalent numerical or algebraic forms will sometimes be written in brackets after the required answer.  
Where numerical answers are required as the final answer to a part of a question in the markscheme, the scheme will show, in order:  
the 3 significant figure answer worked through from full calculator display;  
the exact value (for example  $\sqrt{3}$  if applicable);  
the full calculator display in the form 2.83163... as in the example above.  
Where answers are given to 3 significant figures and are then used in subsequent parts of the question leading to a **different** 3 significant figure answer, these solutions will also be given.

- (f) As this is an international examination, all valid **alternative forms of notation** should be accepted. Some examples of these are:

Decimal points: 1.7; 1'7; 1·7; 1,7 .

Different descriptions of an interval:  $3 < x < 5$ ; (3, 5); ] 3, 5 [ .

Different forms of notation for set properties (for example, complement):  $A'$ ;  $\bar{A}$ ;  $A^c$ ;  $U - A$ ;  $(A; U \setminus A$ .

Different forms of logic notation:  $\neg p$ ;  $p'$ ;  $\tilde{p}$ ;  $\bar{p}$ ;  $\sim p$ .

$p \Rightarrow q$ ;  $p \rightarrow q$ ;  $q \Leftarrow p$  .

- (g) Discretionary marks: There will be very rare occasions where the markscheme does not cover the work seen. In such cases the annotation DM should be used to indicate where an examiner has used discretion. Discretion should be used sparingly and if there is doubt and exception should be raised through scoris to the team leader.

As from Nov 11 there will be no whole paper penalty marks for accuracy AP, financial accuracy FP and units UP. Instead these skills will be assessed in particular questions and the marks applied according to the rules given in sections 5, 6 and 7 below.

### 5 Accuracy of Answers

**Incorrect accuracy should be penalized once only in each question according to the rules below.**

Unless otherwise stated in the question, all numerical answers should be given exactly or correct to 3 significant figures.

1. If the candidate’s unrounded answer is seen and would round to the required 3 sf answer, then award *(AI)* and ignore subsequent rounding.
2. If the candidate’s unrounded answer is **not** seen then award *(AI)* if the answer given is **correctly** rounded to 2 or more significant figures, otherwise *(A0)*.  
**Note:** If the candidate’s unrounded answer is **not** seen and the answer is given correct to 1 sf (correct or not), the answer will be considered wrong and will not count as incorrect accuracy. If this answer is used in subsequent parts, then working must be shown for further marks to be awarded.
3. If a correct 2 sf answer is used in subsequent parts, then working **must** be shown for further marks to be awarded. (This treatment is the same as for following through from an incorrect answer.)

These 3 points (see numbers in superscript) have been summarized in the table below and illustrated in the examples following.

	If candidates final answer is given ...				
	Exact or correct to 3 or more sf	<b>Incorrect to 3 sf</b>	Correct to 2 sf <sup>3</sup>	Incorrect to 2 sf	Correct or incorrect to 1 sf
Unrounded answer seen <sup>1</sup>	Award the final <i>(AI)</i> irrespective of correct or incorrect rounding				
Unrounded answer not seen <sup>2</sup>	<i>(AI)</i>	<i>(A0)</i>	<i>(AI)</i>	<i>(A0)</i>	<i>(A0)</i>
Treatment of subsequent parts	As per MS	Treat as follow through, only if working is seen <sup>3</sup>			

**Examples:**

Markscheme	Candidates' Scripts	Marking
9.43 (9.43398...) (AI)	(i) 9.43398... is seen followed by 9; 9.4; 9.43; 9.434 <i>etc.</i> (correctly rounded)	(AI)
	(ii) 9.43398... is seen followed by 9.433; 9.44 <i>etc.</i> (incorrectly rounded)	(AI)
	(iii) 9.4	(AI)
	(iv) 9	(A0) (correct to 1 sf)
	(v) 9.3	(A0) (incorrectly rounded to 2 sf)
	(vi) 9.44	(A0) (incorrectly rounded to 3 sf)

Markscheme	Candidates' Scripts	Marking
7.44 (7.43798...) (AI)	(i) 7.43798... is seen followed by 7; 7.4; 7.44; 7.438 <i>etc.</i> (correctly rounded)	(AI)
	(ii) 7.43798... is seen followed by 7.437; 7.43 <i>etc.</i> (incorrectly rounded)	(AI)
	(iii) 7.4	(AI)
	(iv) 7	(A0) (correct to 1 sf)
	(v) 7.5	(A0) (incorrectly rounded to 2 sf)
	(vi) 7.43	(A0) (incorrectly rounded to 3 sf)



**Example:** ABC is a right angled triangle with angle  $ABC = 90^\circ$ ,  $AC = 32$  cm and  $AB = 30$  cm . Find (a) the length of BC, (b) The area of triangle ABC.

Markscheme	Candidates' Scripts	Marking
(a) $BC = \sqrt{32^2 - 30^2}$ (MI) Award (MI) for correct substitution in Pythagoras' formula  $= 11.1 (\sqrt{124}, 11.1355...)$ (cm) (AI)	(a) $BC = \sqrt{32^2 - 30^2}$  11 (cm) (AI) (2 sf answer only seen, but correct)	(MI)  (AI)
(b) $Area = \frac{1}{2} \times 30 \times 11.1355...$ (MI) Award (MI) for correct substitution in area of triangle formula  $= 167(167.032...)$ (cm <sup>2</sup> ) (AI)(ft)	(b) case (i) $Area = \frac{1}{2} \times 30 \times 11$  $= 165$ (cm <sup>2</sup> ) (AI)(ft)  case (ii) $= 165$ (cm <sup>2</sup> ) (M0)(A0)(ft) (No working shown, the answer 11 is treated as a ft, so no marks awarded here)	(MI)  (working shown)  (AI)(ft)  (M0)(A0)(ft)

Certain answers obtained from the GDC are worth 2 marks and working will not be seen. In these cases only one mark should be lost for accuracy.

For example, Chi-squared, correlation coefficient, mean

Markscheme	Candidates' Scripts	Marking
Chi-squared	(a) 7.7	(G2)
7.68 (7.67543...) (A2)	(b) 7.67	(G1)
	(c) 7.6	(G1)
	(d) 8	(G0)
	(e) 7	(G0)
	(e) 7.66	(G0)

Regression line

Markscheme	Candidates' Scripts	Marking
$y = 0.888x + 13.5$ (A2) ( $y = 0.887686\dots x + 13.4895\dots$ ) If an answer is not in the form of an equation award at most (AI)(A0).	(a) $y = 0.89x + 13$	(G2) (both accepted)
	(b) $y = 0.88x + 13$	(G1) (one rounding error)
	(c) $y = 0.88x + 14$	(G1) (rounding error repeated)
	(d) (i) $y = 0.9x + 13$	(G1) (1 sf not accepted)
	(ii) $y = 0.8x + 13$	
(e) $0.88x + 13$	(G0) (one rounding error and not an equation)	

Maximum/minimum/points of intersection

Markscheme	Candidates' Scripts	Marking
(2.06, 4.49) (AI)(AI) (2.06020..., 4.49253...)	(a) (2.1, 4.5)	(AI)(AI) (both accepted)
	(b) (2.0, 4.4)	(AI) (same rounding error twice)
	(c) (2.06, 4.4)	(AI) (one rounding error)
	(d) (2, 4.4)	(A0) (1sf not accepted, one rounding error)

Rounding of an exact answer to 3 significant figures **should be accepted if performed correctly**.

Exact answers such as  $\frac{1}{4}$  can be written as decimals to fewer than three significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential, however where an answer simplifies to an integer this is expected.

Ratios of  $\pi$  and answers taking the form of square roots of integers or any rational power of an integer (for example,  $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}$ ,) may be accepted as exact answers. All other powers (for example, of non-integers) and values of transcendental functions such as sine and cosine must be evaluated.

**If the level of accuracy is specified in the question, a mark will be allocated for giving the answer to the required accuracy.** In all such cases the final mark is not awarded if the rounding does not follow the instructions given in the question. A mark for specified accuracy can be regarded as a (ft) mark regardless of an immediately preceding (M0).

**6 Level of accuracy in finance questions**

The accuracy level required for answers will be specified in all questions involving money. This will usually be either whole units or two decimal places. The first answer not given to the specified level of accuracy will not be awarded the final **A** mark. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for incorrect accuracy in a financial question.

**Example:** A financial question demands accuracy correct to 2 dp.

Markscheme	Candidates' Scripts	Marking
\$231.62 (231.6189) <b>(AI)</b>	(i) 231.6	<b>(A0)</b>
	(ii) 232	<b>(A0)</b> <i>(Correct rounding to incorrect level)</i>
	(iii) 231.61	<b>(A0)</b>
	(iv) 232.00	<b>(A0)</b> <i>(Parts (iii) and (iv) are both incorrect rounding to correct level)</i>

**7 Units in answers**

There will be specific questions for which the units are required and this will be indicated clearly in the markscheme. The first correct answer with no units or incorrect units will not be awarded the final **A** mark. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for lack of units or incorrect units.

The units are considered only when the numerical answer is awarded **(AI)** under the accuracy rules given in Section 5.

**Example:**

Markscheme	Candidates' Scripts	Marking
(a) 37000 m <sup>2</sup> <b>(AI)</b>	(a) 36000 m <sup>2</sup>	<b>(A0)</b> <i>(Incorrect answer so units not considered)</i>
(b) 3200 m <sup>3</sup> <b>(AI)</b>	(b) 3200 m <sup>2</sup>	<b>(A0)</b> <i>(Incorrect units)</i>

**If no method is shown and the answer is correct but with incorrect or missing units award G marks with a one mark penalty.**

**8 Graphic Display Calculators**

Candidates will often be obtaining solutions directly from their calculators. They must use mathematical notation, not calculator notation. No method marks can be awarded for incorrect answers supported only by calculator notation. The comment 'I used my GDC' cannot receive a method mark.

**QUESTION 1**

(a) (i)  $\frac{71+79+\dots}{12}$  (MI)

$72.4 \left( 72.4166\dots, \frac{869}{12} \right)$  (AI)(G2)

**Note:** Award (MI) for correct substitution into the mean formula.

(ii) 4.77 (4.76896...) (GI)

(iii)  $72.4 + 4.77 = 77.17$  (MI)

**Note:** Award (MI) for adding their mean to their standard deviation.

Two golfers (AI)(ft)(G2) [5 marks]

**Note:** Follow through from their answers to parts (i) and (ii).

(b) 0.990 (0.99014...) (G2) [2 marks]

(c)  $y = 1.01x + 0.816$  ( $y = 1.01404\dots x + 0.81618\dots$ ) (GI)(GI)

**Notes:** Award (GI) for 1.01x and (GI) for 0.816. If the answer is not an equation award a maximum of (GI)(G0).

**OR**

$y - 74.25 = 1.01(x - 72.4)$  ( $y - 74.25 = 1.01404\dots(x - 72.4166\dots)$ ) (AI)(AI) [2 marks]

**Notes:** Award (AI) for 1.01 correctly substituted in the equation, and (AI)(ft) for correct substitution of (72.4, 74.25) in the equation.  
Follow through from their part (a)(i).  
If the final answer is not an equation award a maximum of (AI)(A0).

(d)  $y = 1.01404\dots \times 70 + 0.81618\dots$  (MI)

**Note:** Award (MI) for substitution of 70 into their regression line equation from part (c).

$y = 72$  (71.7989...) (AI)(ft)(G2) [2 marks]

**Note:** Follow through from their part (c).

continued...

*Question 1 continued*

- (e) No, equation cannot be (reliably) used as 89 is outside the data range. (AI)(RI)

**OR**

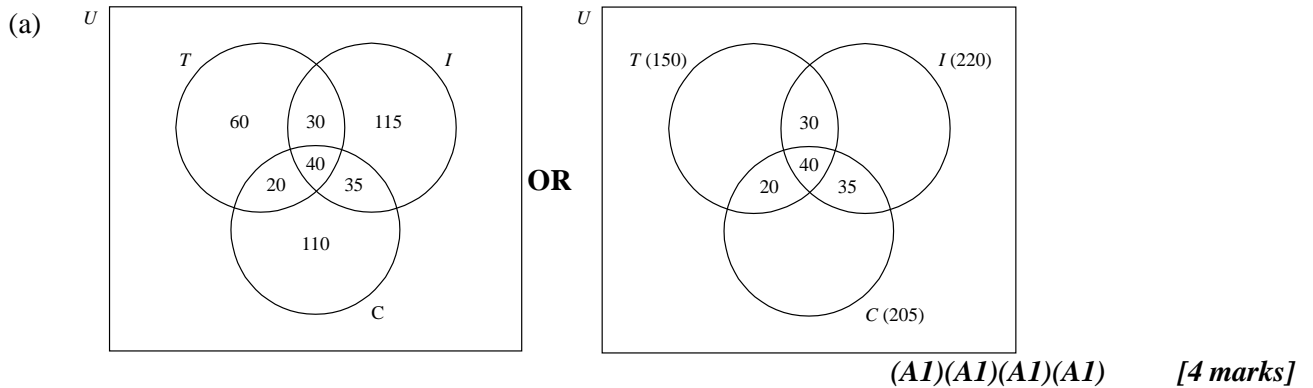
Yes, but the result is not valid/not reliable as 89 is outside the data range/as we extrapolate

(AI)(RI) [2 marks]

<b>Note:</b> Do not award (AI)(R0).
-------------------------------------

**Total [13 marks]**

**QUESTION 2**



**Notes:** Award *(AI)* for labelled sets *T*, *C*, and *I* included inside an enclosed universal set. (Label *U* is not essential.)  
 Award *(AI)* for central entry 40.  
*(AI)* for 20, 30 and 35 in the other intersecting regions.  
*(AI)* for 60, 110 and 115 or *T(150)*, *C(205)*, *I(220)*.

*In parts (b), (c) and (d) follow through from their diagram.*

- (b) (i) 110 *(AI)(ft)*
- (ii) 35 *(AI)(ft)* [2 marks]
- (c) 60 *(AI)(ft)* [1 mark]
- (d)  $450 - (60 + 20 + 40 + 30 + 115 + 35 + 110)$  *(MI)*

**Note:** Award *(MI)* for subtracting all their values from 450.

$= 40$  *(AI)(ft)(G2)* [2 marks]

(e) (i)  $\frac{230}{450} \times \frac{229}{449}$  *(AI)(MI)*

**Note:** Award *(AI)* for correct fractions, *(MI)* for multiplying their fractions.

$\frac{52670}{202050} \left( \frac{5267}{20205}, 0.261, 26.1\% \right) (0.26067\dots)$  *(AI)(G2)*

**Note:** Follow through from their Venn diagram in part (a).

*continued...*

Question 2 continued

(ii)  $\frac{220}{450} \times \frac{230}{449} + \frac{230}{450} \times \frac{220}{449}$  (AI)(AI)

**Note:** Award (AI) for addition of their products, (AI) for two correct products.

**OR**

$\frac{230}{450} \times \frac{220}{449} \times 2$  (AI)(AI)

**Notes:** Award (AI) for their product of two fractions multiplied by 2, (AI) for correct product of two fractions multiplied by 2. Award (A0)(A0) if correct product is seen not multiplied by 2.

$\frac{2024}{4041}$  (0.501, 50.1%) (0.50086...) (AI)(G2) [6 marks]

**Note:** Follow through from their Venn diagram in part (a) and/or their 230 used in part (e)(i).

**Note:** For consistent use of replacement in parts (i) and (ii) award at most (A0)(MI)(A0) in part (i) and (AI)(ft)(AI)(AI)(ft) in part (ii).

(f) (i)  $x + 9y = 13050$  (AI)

(ii)  $x = 900$  (AI)(ft)  
 $y = 1350$  (AI)(ft) [3 marks]

**Notes:** Follow through from their equation in (f)(i). Do not award (AI)(ft) if answer is negative. Award (MI)(A0) for an attempt at solving simultaneous equations algebraically but incorrect answer obtained.

continued...

Question 2 continued

(g)  $49500 = 900 + 1350n$  (AI)(ft)

**Notes:** Award (AI)(ft) for setting up correct equation. Follow through from candidate's part (f).

$n = 36$  (AI)(ft)

The total number of months is 37. (AI)(ft)(G2)

**Note:** Award (GI) for 36 seen as final answer with no working. The value of  $n$  must be a positive integer for the last two (AI)(ft) to be awarded.

**OR**

$49500 = 900 + 1350(n - 1)$  (A2)(ft)

**Notes:** Award (A2)(ft) for setting up correct equation. Follow through from candidate's part (f).

$n = 37$  (AI)(ft)(G2) [3 marks]

**Note:** The value of  $n$  must be a positive integer for the last (AI)(ft) to be awarded.

**Total [21 marks]**



**QUESTION 3** Units are required in part (c) only.

(a)  $BC^2 = 5^2 + 7^2 - 2(5)(7)\cos 112^\circ$  (MI)(AI)

**Note:** Award (MI) for substitution in cosine formula, (AI) for correct substitutions.

$BC = 10.0 \text{ (m) (10.0111...)}$  (AI)(G2) [3 marks]

**Note:** If radians are used, award at most (MI)(AI)(A0).

(b)  $\frac{\sin 40^\circ}{10.0111...} = \frac{\sin \hat{D}CB}{6}$  (MI)(AI)(ft)

**Notes:** Award (MI) for substitution in sine formula, (AI)(ft) for their correct substitutions. Follow through from their part (a).

$\hat{D}CB = 22.7^\circ \text{ (22.6589...)}$  (AI)(ft)

**Notes:** Award (A2) for  $22.7^\circ$  seen without working. Use of radians results in unrealistic answer. Award a maximum of (MI)(AI)(ft)(A0)(ft). Follow through from their part (a).

$\hat{D}BC = 117^\circ \text{ (117.341...)}$  (AI)(ft)(G3)

**Notes:** Do not penalize if use of radians was already penalized in part (a). Follow through from their answer to part (a).

**OR**

From use of cosine formula  
 $DC = 13.8 \text{ (m) (13.8346...)}$

(AI)(ft)

**Note:** Follow through from their answer to part (a).

$\frac{\sin \alpha}{13.8346...} = \frac{\sin 40^\circ}{10.0111...}$  (MI)

**Note:** Award (MI) for correct substitution in the correct sine formula.

$\alpha = 62.7^\circ \text{ (62.6589...)}$  (AI)(ft)

**Note:** Accept  $62.5^\circ$  from use of 3sf.

$\hat{D}BC = 117 \text{ (117.341...)}$  (AI)(ft) [4 marks]

**Note:** Follow through from their part (a). Use of radians results in unrealistic answer, award a maximum of (AI)(MI)(A0)(A0).

continued...

Question 3 continued

(c)  $\text{Area ABDC} = \frac{1}{2}(5)(7)\sin 112^\circ + \frac{1}{2}(6)(10.0111\dots)\sin 117.341\dots^\circ$  (MI)(AI)(ft)(MI)

**Note:** Award (MI) for substitution in both **triangle** area formulae, (AI)(ft) for their correct substitutions, (MI) for seen or implied addition of their two **triangle** areas. Follow through from their answer to part (a) and (b).

$= 42.9 \text{ m}^2$  (42.9039...) (AI)(ft)(G3) [4 marks]

**Notes:** Answer is  $42.9 \text{ m}^2$  *i.e.* **the units are required** for the final (AI)(ft) to be awarded. Accept  $43.0 \text{ m}^2$  from using 3sf answers to parts (a) and (b). Do not penalize if use of radians was previously penalized.

(d)  $42.9039\dots \times 0.5$  (MI)(MI)

**Note:** Award (MI) for 0.5 seen (or equivalent), (MI) for multiplication of their answer in part (c) with their value for depth.

$= 21.5 \text{ (m}^3)$  (21.4519...) (AI)(ft)(G3) [3 marks]

**Note:** Follow through from their part (c) **only if working is seen**. Do not penalize if use of radians was previously penalized. Award at most (A0)(MI)(A0)(ft) for multiplying by 50.

(e) (i)  $\pi(0.15)^2(0.4)$  (MI)(AI)

**OR**

$\pi \times 15^2 \times 40$  (28274.3...) (MI)(AI)

**Notes:** Award (MI) for substitution in the correct volume formula. (AI) for correct substitutions.

$= 0.0283 \text{ (m}^3)$  (0.0282743...,  $0.09\pi$ )

(ii)  $\frac{21.4519\dots}{0.0282743\dots}$  (MI)

**Note:** Award (MI) for correct division of their volumes.

$= 759$  (AI)(ft)(G2) [5 marks]

**Notes:** Follow through from their parts (d) and (e)(i). Accept 760 from use of 3sf answers. Answer must be a positive integer for the final (AI)(ft) mark to be awarded.

**Total [19 marks]**

**QUESTION 4**

- (a) (i)  $\frac{220}{500} \left( \frac{11}{25}, 0.44, 44\% \right)$  (AI)(GI)
- (ii)  $\frac{180}{500} \left( \frac{9}{25}, 0.36, 36\% \right)$  (AI)(GI)
- (iii)  $\frac{40}{500} \left( \frac{2}{25}, 0.08, 8\% \right)$  (AI)(AI)(G2)
- (iv)  $\frac{55}{280} \left( \frac{11}{56}, 0.196, 19.6\% \right)$  (AI)(AI)(G2) [6 marks]

**Note:** Award (AI) for numerator, (AI) for denominator. Award (A0)(A0) if answers are given as incorrect reduced fractions without working.

- (b) “The size of the television screen is independent of gender.” (AI) [1 mark]

**Note:** Accept “not associated”, do not accept “not correlated”.

- (c)  $\frac{180}{500} \times \frac{220}{500} \times 500$  OR  $\frac{180 \times 220}{500}$  (MI)
- = 79.2 (AI)
- = 79 (AG) [2 marks]

**Note:** Both the unrounded and the given answer must be seen for the final (AI) to be awarded.

- (d) 3 (AI) [1 mark]

- (e)  $\chi^2_{calc} = 104$  (103.957...) (G2) [2 marks]

**Note:** Award (MI) if an attempt at using the formula is seen but incorrect answer obtained.

- (f) 11.345 (AI)(ft) [1 mark]

**Notes:** Follow through from their degrees of freedom.

- (g)  $\chi^2_{calc} > \chi^2_{crit}$  OR  $p < 0.01$  (RI)
- Do not accept  $H_0$ . (AI)(ft) [2 marks]

**Note:** Do not award (R0)(AI)(ft). Follow through from their parts (d), (e) and (f).

**Total [15 marks]**

**QUESTION 5**

(a)  $x = 0$  (AI)(AI) [2 marks]

**Notes:** Award (AI) for  $x = \text{constant}$ , (AI) for 0. Award (A0)(A0) if answer is not an equation.

(b)  $b - \frac{2}{x^3}$  (AI)(AI)(AI) [3 marks]

**Note:** Award (AI) for  $b$ , (AI) for  $-2$ , (AI) for  $\frac{1}{x^3}$  (or  $x^{-3}$ ).  
Award at most (AI)(AI)(A0) if extra terms seen.

(c)  $3 = b - \frac{2}{(1)^3}$  (MI)(MI)

**Note:** Award (MI) for substituting 1 into their gradient function, (MI) for equating their gradient function to 3.

$b = 5$  (AG) [2 marks]

**Note:** Award at most (MI)(A0) if final line is not seen or  $b$  does not equal 5.

(d)  $g(1) = 3$  or  $(1, 3)$  (seen or implied from the line below) (AI)

$3 = 3 \times 1 + c$  (MI)

**Note:** Award (MI) for correct substitution of their point  $(1, 3)$  and gradient 3 into equation  $y = mx + c$ . Follow through from their point of tangency.

$y = 3x$  (AI)(ft)(G2)

**OR**

$y - 3 = 3(x - 1)$  (MI)(AI)(ft)(G2) [3 marks]

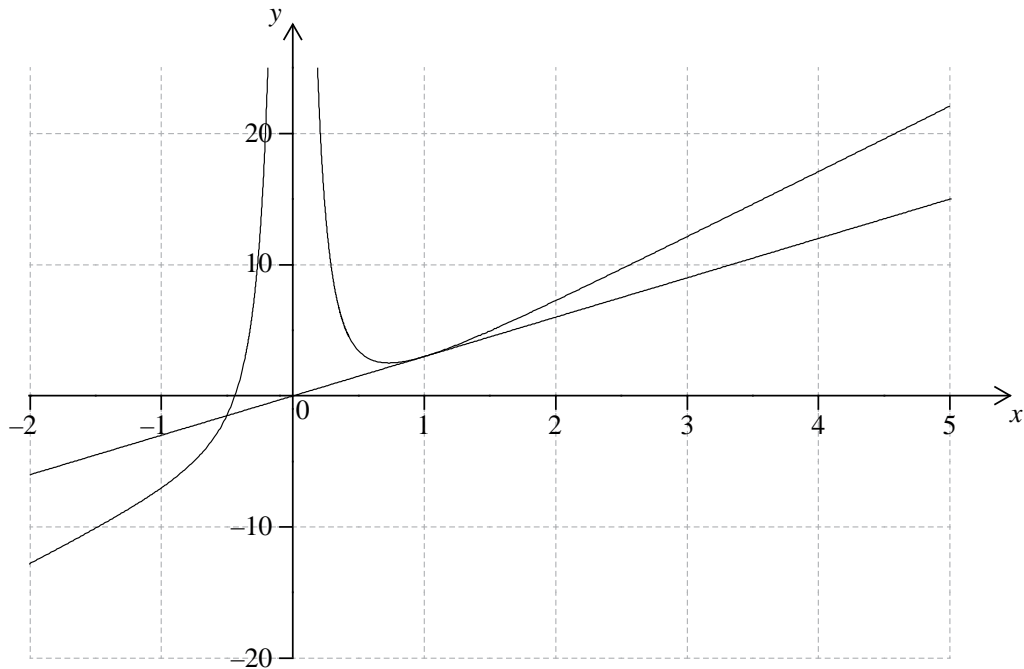
**Note:** Award (MI) for substitution of gradient 3 and their point  $(1, 3)$  into  $y - y_1 = m(x - x_1)$ , (AI)(ft) for correct substitutions. Follow through from their point of tangency. Award at most (AI)(MI)(A0)(ft) if further incorrect working seen.

(e)  $(-0.439, 0)$   $((-0.438785\dots, 0))$  (G1)(G1) [2 marks]

**Notes:** If no parentheses award at most (G1)(G0).  
Accept  $x = -0.439$ ,  $y = 0$ .

Question 5 continued

(f) (i)



Award **(AI)** for labels and some indication of scale in the stated window.

Award **(AI)** for correct general shape (curve must be smooth and must not cross the y-axis)

Award **(AI)(ft)** for x-intercept consistent with their part (e).

Award **(AI)** for local minimum in the first quadrant. **(AI)(AI)(AI)(ft)(AI)**

(ii) Tangent to curve drawn at approximately  $x = 1$

**(AI)(AI)**

**[6 marks]**

**Note:** Award **(AI)** for a line tangent to curve approximately at  $x = 1$ .  
Must be a straight line for the mark to be awarded.  
Award **(AI)(ft)** for line passing through the origin. Follow through from their answer to part (d).

(g)  $(0.737, 2.53)$   $((0.736806\dots, 2.52604\dots))$

**(GI)(GI)**

**[2 marks]**

**Notes:** Do not penalize for lack of parentheses if already penalized in (e).  
Accept  $x = 0.737, y = 2.53$ .

(h)  $0.737 < x < 5$  **OR**  $(0.737;5)$

**(AI)(AI)(ft)**

**[2 marks]**

**Notes:** Award **(AI)** for correct strict or weak inequalities with  $x$  seen if the interval is given as inequalities, **(AI)(ft)** for 0.737 and 5 or their value from part (g).

**Total [22 marks]**